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A THERMALLY INSULATING PANEL & WALL CONSTRUCTED THEREFROM

Field of the Invention

The present invention relates to a building panel and wall construction made therefrom. In particular, the invention relates to a thermally insulating wall structure which finds particular application in buildings constructed in areas having extremes of either hot or cold, or both.

Background Art

US Patents Nos. 5,667,190; 5,922,235; 6,186,469 and 6,186,469 (Scott/assignee Scott System Inc.) disclose a concrete panel of simulated brick appearance and various bracket devices for maintaining brick pavers in situ during formation of the concrete panel. Although such panels address problems caused by the scarcity of bricklayers, they do not address the thermal problems associated with conventional masonry structure.

In particular, the increasing price of energy and greenhouse gas consideration mean that the consumption of energy in both heating and cooling dwellings must be reduced. As a consequence, conventional masonry walls (including both double brick and brick veneer construction) are unable to meet the thermal insulation specification required of modern construction. For example, a brick veneer wall has an R rating of approximately 0.45-0.47, and a double brick wall has an R rating of approximately 0.5-0.52. Even with fiberglass insulation batts installed in the cavity of a brick veneer wall the R rating is only increased to approximately 1.5-2.0. However, modern building specifications call for an R rating for walls of approximately 3 or better.

Object of the Invention

Many forms of thermally insulating wall construction have been proposed, however, in order to be practical not only must the level of thermal insulation be good, but the wall must be structurally strong and easy to construct. Unless a particular wall construction meets all three of these desiderata, it is unlikely to be commercially successful.

The object of the present invention is to provide an improved wall construction which makes use of both the concept of a cavity wall, and also the thermally insulating properties of reflective sheets, for example those fabricated from metal foils or metal coated films.

Summary of the Invention

In accordance with a first aspect of the present invention there is disclosed a thermally insulating wall construction comprising a pair of masonry panels each having an internal surface and an observable surface and being arranged with said internal surfaces facing each other to define an air cavity between said panels, said internal surfaces each having a plurality of recesses interspersed between protrusions, and said wall construction having at least one reflective sheet which extends between adjacent protrusions, and which is spaced from the interior of said recesses.

In accordance with a second aspect of the present invention there is disclosed a method of fabricating a panel for use in the abovementioned wall construction, said method comprising the steps of:

(i) creating a mould for said panel,

(ii) placing a shaped former in said mould to form said recesses and protrusions,

(iii) pouring a flowable hardenable cementitious substance onto said former within said mould and allowing same to set, and

(iv) removing said set material and former from said mould whereby said former is retained in situ in said panel.

In accordance with a third aspect of the present invention there is disclosed a masonry panel having an internal surface and an observable surface, said internal surface having a plurality of recesses interspersed between protrusions, and at least one reflective sheet which extends between adjacent protrusions and which is spaced from the interior of said recesses.

Brief Description of the Drawings

Several embodiments of the present invention will now be described with reference to the drawings in which:

Fig. 1 is a schematic perspective cut away view of a wall constructed in accordance with the first embodiment of the present invention,

Fig. 2 is a perspective view of the interior surface of either one of the panels from which the wall of Fig. 1 is constructed,

Fig. 3 is a substantially horizontal and transverse cross sectional view taken through the wall construction of Fig. 1,

Fig. 4 is a view similar to Fig. 3 but of a second embodiment,

Fig. 5 is a view similar to Fig. 4 but showing a third embodiment,

Fig. 6 is a vertical cross-sectional view through a mould used to form the panel of a fourth embodiment,

Fig. 7 is a view similar to Fig. 3 but showing a wall constructed from the panels of Fig. 6,

Fig. 8 is a view similar to Figs. 3 and 7 but showing a wall of a still further embodiment, and

Fig. 9 is a schematic perspective view of a stud and joist arrangement for multistorey buildings using the wall construction of Fig. 8.

<u>Detailed Description</u>

As seen in Fig. 1, the wall 1 of the first embodiment sits on a foundation 2 which in the first embodiment is a concrete slab 3. However, the foundation 2 could equally be a timber or metal foundation formed from beams or the like. The wall 1 is fabricated from two like panels 5 and which in Fig. 1 are indicated as an exterior panel 5A and an interior panel 5B. The base of the exterior panel 5A sits on a Z-shaped galvanised locating strip 7 whilst the base of the interior panel 5B abuts a lip 8 in the slab 3.

At their upper edges, the panels 5A and 5B are retained within an E-shaped galvanised cap plate 9. The cap plate 9 has a centrally located and longitudinally extending groove 10 the dimensions of which define the corresponding dimensions of an interior cavity 12 formed between the two panels 5A and 5B. Located in the slab 3 below the cavity 12 is a slot 13 within which, at spaced apart intervals along the length of the wall 1, a number of threaded rods 15 (only one of which is illustrated) are positioned. The rods 15 are maintained in a vertical orientation by means of a

chemical anchor (such as a two part epoxy resin) which surrounds the lower end of each rod 15 and binds it with the slot 13. The upper end of each of the threaded rods 15 passes through a corresponding hole in the groove 10 and carries a nut 16 which enables the rod 15 to be placed in tension to thereby urge the cap plate 9 against the panels 5 which are thereby placed in compression. A length of sealing tape 18, which is illustrated in truncated fashion in Fig. 1, is used to seal each side edge of the cavity 12. In this way the air within the cavity 12 remains stagnant and does not move or circulate.

As seen in Fig. 2, each of the panels 5 has an internal surface 21 and an observable surface 22 which may form either the exterior of the wall 1 or the interior of the wall 1. The internal surface 21 is provided with a series of vertically orientated, longitudinally extending and substantially parallel grooves 24 and ridges 25. The grooves 24 are substantially semi-circular in configuration whilst the ridges 25 have flat topped crests 26.

Illustrated in cutaway fashion in Fig. 2 is a scalloped sheet of double sided aluminium foil or double sided aluminium coated film 28 which extends over the entire internal surface 21 and is truncated in Fig. 2 to reveal the structure of the grooves 24. The film 28 is provided with flats 29 and curves 30. The radius of curvature of curves 30 is less than the corresponding radius of curvature of the grooves 24.

As best seen in Fig. 3, when the two panels 5A, 5B are arranged with their internal surfaces 21 facing each other, the gap between the crests 26 is preferably filled by a packing strip 31 of polystyrene, or similar material, which extends along the length of each crest 26 or at least partially therealong. The packing strips 31 may be provided as a single piece as illustrated in Fig. 3 or as two pieces which abut each other so that both panels 5A and 5B are entirely identical. The packing strip 31 preferably provides a measure of resilience, or an ability to absorb shocks arising from horizontal forces applied to the observable surfaces 22.

To those skilled in the thermally insulating arts, it will be apparent from Fig. 3 that a number of sequential thermal barriers are erected. The first thermal barrier is the observable surface 22 and the thickness of the panel 5A between the observable surface 22 and the base of the groove 24. The next barrier is the air barrier between the base of the groove 24 and the exterior surface of the film 28. The next barrier is formed by the interior of the film 28 whilst the next barrier is formed by the air gap between the two films 28. The next barrier is the interior of the second film 28. Similarly, the following barrier is the exterior surface of that film 28. The next barrier is again the air gap between the second film 28 and the base of the groove 24 in the panel 5B. The final barrier is the thickness between the observable surface 22 of the panel 5B and the base of the grooves 24. The sequential barriers result in the accumulation of desirable thermally insulating properties and results in a very high R rating, typically approximately 4 for the construction of Figs. 1-3.

Turning now to Fig. 4, a second embodiment of a wall 100 is illustrated therein. The wall 100 is similar to that of the first embodiment except that the grooves 124 and ridges 125 have a different profile and only a single film 128 coated on each side with aluminium in order to form a reflective thermal barrier. The polystyrene packing strips 131 are essentially as before. The R rating for this embodiment is typically approximately 2.5.

In a third embodiment illustrated in Fig. 5, the wall 199 is formed from two panels as in Fig. 4 but instead of a single film 128, four separate film layers 128 are provided with a correspondingly increased number of polystyrene packing slips 131 so that each film 128 is spaced from the others. Thus many layers of stagnant air are created and a correspondingly increased thermal rating R of approximately 7 is the result.

Turning now to Fig. 6, a fourth embodiment of the panel 205 and its method of fabrication will now be described. The panel is formed in a mould 201 which has a rectangular base 202 and two fixed end walls (not illustrated) and two hinged side walls 203 and 204. The side wall 203 has a protrusion 206 which forms a

corresponding groove 207 in one edge of the panel 205. The side wall 204 has a recess 208 which forms a tongue 209 in the other edge of the panel 205.

In order to carry out the moulding procedure, firstly the side walls 203 and 204 are pivoted downwardly about hinges 220 so as to lie in a substantially horizontal position generally flush with the base 202. Then a planar and rectangular spacer 211 (which preferably takes the form of a fibre cement sheet 6mm thick) is placed in the mould 201. The width of the spacer 211 is such that it does not reach quite to the hinges 220. Over the spacer 211 is laid a thin sheet of aluminium foil 228. Over the interior of each of the end walls and the side walls 203, 204 is located a layer of polyethylene film 219. Such film is widely used in kitchen applications to cover bowls of salad, etc which are placed in a domestic fridge. The purpose of the film 219 is simply to act as a release agent and ensure that the end walls and side walls 203, 204 are maintained clean between individual moulding applications. In particular, the film 219 extends over the hinges 220 so as to maintain same free of liquid cement during the moulding procedure. If the polyethylene film 219 is not used, commercially available spray on release agents can be used instead.

On top of the aluminium foil 228 is placed a dimpled or castellated sheet 227 fabricated from moulded or pressed paper or cardboard material. Such sheets 227 are widely used in the egg industry as one portion of a two portion container for eggs. Such sheets 227 are inexpensive and provide a convenient means of forming the desired pattern of protrusions and recesses on the interior surface of the panel 205. Such sheets 227 are also used for pears, apples, tomatoes etc and so a number of such sheets each with a different profile and/or dimensions, are available.

Once the film 219 and egg carton sheet 227 are in place, the side walls 203 and 204 are swung up into, and latched in, a vertical position in which they are substantially perpendicular to the base 202. Then lightweight concrete mixture 217 is poured into the mould 201 and on top of the egg carton sheet 227. Although the egg carton sheet 227 absorbs moisture from the concrete mixture, it is sufficiently strong to maintain the concrete 217 in position until it takes its first set. If desired, the egg

carton sheet 227 can be treated by being sprayed with lacquer, varnish or similar to make same to some extent water impervious.

Once the lightweight concrete 217 has set, the side walls 203 are unlatched and pivoted about the hinges 220. This enables the solidified slab 205 to be lifted clear of the mould 201. The aluminium foil 228 comes away with the panel 205 and thus is formed together with the panel 205 and does not need to be added as a subsequent step.

In Fig. 7, a plurality of the panels 205A and 205B are placed together to form a wall 200 having an interior cavity 212. The grooves 207 and tongues 209 are mated so as to form an effective seal between adjacent panels 205A and adjacent panels 205B. To either side of the cavity 212 lies a layer of aluminium foil 228. On the side of each layer of aluminium foil 228 away from the cavity 212, lies a plurality of enclosed air spaces 235 each of which is formed by the pattern on the egg carton sheet 227.

If desired, the observable surfaces 222 of the panels 205A, 205B can be covered with a thin layer of lining board 236 (preferably 2.5mm in thickness) which is glued to the panels 205 and provides a similar external appearance to that of plasterboard for a flush finish. The liner board 236 conveniently conceals the abutting edges of adjacent panels 205. Preferably to reduce acoustic and thermal transmission through the wall 200, the abutting edges of adjacent panels 205A are staggered, or are offset, relative to the abutting edges of adjacent panels 205B.

As before, the arrangement of the panels 205A and 205B means that there are many interfaces between the opposite observable sides of the wall 200 and thus an extremely high R rating (typically between 5 and 10) for the wall is able to be achieved which results in very low thermal transmission through the wall 200. The wall 200 also has a good acoustic performance, however, this can be improved by locating (as illustrated in Fig. 6) a layer of fibrous filling 229 (such as that sold under the trade mark TONTINE) between the egg carton sheet 227 and the spacer 211. Such fibrous filling 229 is compressed between the egg carton sheet 227 and the

aluminium foil 228 but remains uncompressed under the spaces and thereby fills the spaces 235. As a result these voids are filled and therefore the creation of sympathetic vibrations within the voids of the air spaces 235 is avoided. This improves the acoustic performance.

A still further embodiment is illustrated in Fig. 8 where the cross-sectional profile of the panel 305 used to form a wall 300 is modified so as to provide longitudinally extending grooves 306 formed at spaced apart intervals across each panel 305. With the panels 305A and 305B arranged to form the wall 300 as illustrated in Fig. 8, at various locations along the wall two grooves 306 are positioned in an opposed relationship thereby forming a convenient substantially round slot into which a stud 310 may be located, if desired. In this way, the panels 305 can be used to form a cladding either side of load bearing studs 310 so as to form a wall of substantially increased load bearing ability. The studs 310 are preferably formed from 50mm diameter round extruded galvanised pipe section.

In particular, as indicated in Fig. 9 the studs 310 are spanned by a formed beam 320 created from two L-shaped rolled metal strips which are pop riveted at 325 or otherwise joined together. The formed beam 320 is able to be inexpensively manufactured but has a high bending moment and is therefore sufficiently strong to support the floor joists 330 of an upper floor in a building having two floors or even multiple floors.

The foregoing describes only some embodiments of the present invention and modifications, obvious to those skilled in the art, can be made thereto without departing from the scope of the present invention. For example, the aluminium foil or film 28 can be perforated in the region of each crest 26 to allow an adhesive bonding cement to bond between the panels 5, through the foil or film 28 and on to the packing strip 31. The foil or film 28 preferably has some "memory" and can therefore be bent during handling but then return to the intended scalloped shape. Similarly, the grooves 24, 124 can be of any shape or profile. In addition, in multi-storey buildings, the rods 15 can be dispensed with as the upper floors maintain the panels 5 in compression. It will also be understood that in the drawings the scale of some objects

such as the aluminium coated foil 28, 128, 228 and the film 219 is exaggerated in order to make same visible. Similarly, the masonry can be formed in ways other than by casting lightweight concrete, however, this is the most efficient.

The term "comprising" (and its grammatical variations) as used herein is used in the inclusive sense of "having" or "including" and not in the exclusive sense of "consisting only of".